Using XCSoar as a Problem-Solving Tool

How a glide computer can help solve many of your problems when flying cross-country

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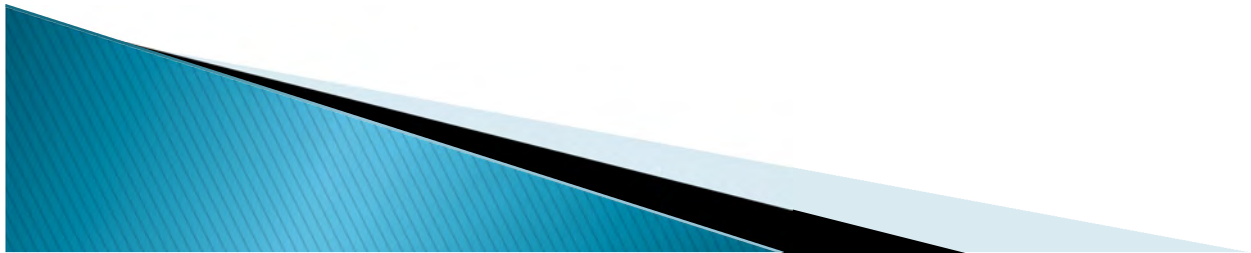
What this presentation will cover

- A quick overview of glide computers
- A quick overview of XCSoar
- Problems you might encounter and how XCSoar can help you solve them
- Questions and answers
  - but feel free to ask questions along the way
- The presentation focuses on cross-country flying, but much of it is also relevant to flying at Camden



What is a glide computer?

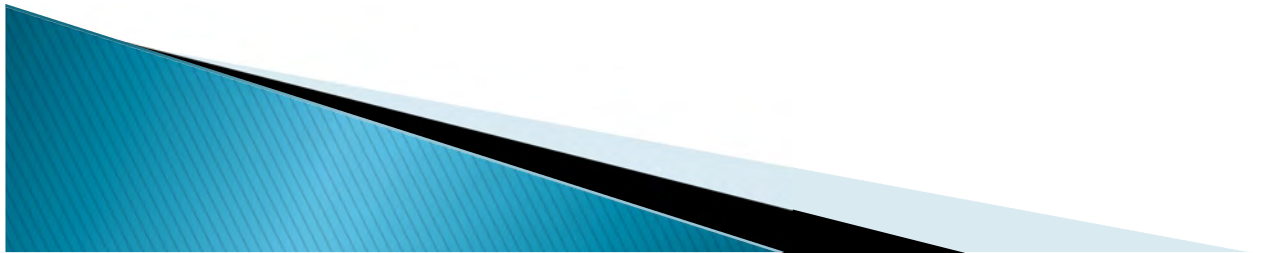
- As the name implies, it's a computer…
- …with some specialised gliding software
- …and a GPS receiver so it knows where you are
- …and (usually) maps and waypoints so it knows what is below you
- …and (sometimes) airspace information so it knows what airspace restrictions are around you
- The Cambridge 303 in the DG-303 is a glide computer, although it doesn't have maps or airspace information
- The new LXNAV LX 8080 in the DG-1000 is a more modern glide computer

Some glide computers

Clockwise from left: Oudie running SeeYou Mobile, Cambridge 303, Altair running XCSoar, LX 8080 (shown to scale)

What is XCSoar?

- It's the software component of the glide computer
- You supply the computer and GPS receiver
- You can download the software from the XCSoar web site (`www.xcsoar.org`) or install the Android app from Google Play
- You can download maps, waypoints and airspace information from the Internet
- XCSoar is open source software
  - It's free for anyone to use
  - New versions and updates are released frequently



What hardware does XCSoar need?

- The simplest option is a modern Android smartphone (eg HTC, LG, Samsung, Sony)
  - XCSoar isn't available for the iPhone or iPad, or Windows Phone
- Another option is a small Android tablet with built-in GPS
- Using a car navigation GPS works, but only on some brands (eg Navman) and you need to hack the device first
  - XCSoar doesn’t work on Garmin or TomTom car GPSs
- Another option is a Kobo eBook reader (eg Kobi Mini), but this is experimental and you have to attach a GPS receiver
- Using a PDA (eg iPAQ) was common in years past, but PDAs are a superseded technology
- You can run XCSoar on your PC at home to experiment

What else do you need for XCSoar?

- Some way to mount the device securely in the cockpit
  - Most smartphones have suction mounts available from the manufacturer
  - All car GPSs come with suction mounts
  - Third party suction mounts (eg from RAM Mount) may be expensive but can work well
- Some way to supply additional power
  - The internal battery in your device is probably fine for an hour's flying around Camden, but for a long cross-country flight you need supplementary power
  - Small USB battery packs are readily available at a reasonable price

The XCSoar user interface

- The standard XCSoar screen shows a moving map and some “InfoBoxes”
  - You need to install a map for your region
- The InfoBoxes display useful information
  - There are lots of InfoBoxes to choose from (100+)
  - You choose which ones you want displayed
  - You configure how many you want displayed and where they appear on the screen
- You configure how you want XCSoar to work
  - There are lots of settings to configure (150+)
  - Configure the settings before you fly, not in the air!
- You access the settings by double-tapping on the screen, then following the menus
- You can “draw” on the screen to access some of XCSoar’s features
  - eg swiping up or down zooms the map in or out
- The screen can be oriented in portrait or landscape mode, but is shown here in portrait mode for convenience

Some problems XCSoar can help you solve

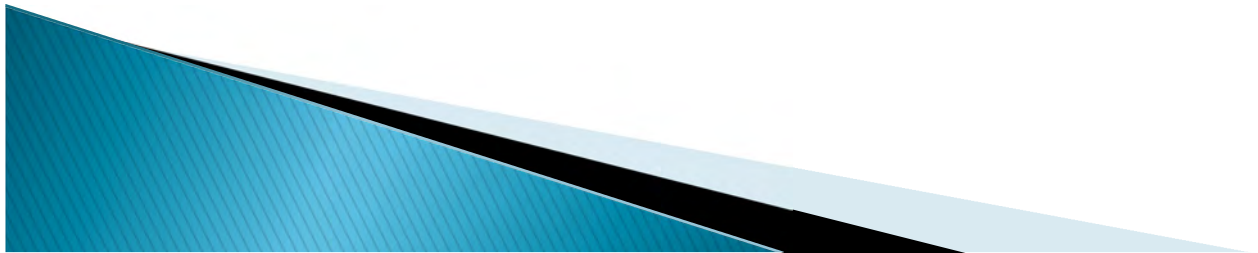
- Where am I?
- Which way is the wind blowing?
- How do I centre this thermal?
- How good are the flying conditions?
- How fast should I fly?
- How high should I fly?
- Am I infringing airspace restrictions?
- Which direction should I fly?
- How well am I flying?
- How far to the next turnpoint?
- How do I ensure that I fly around the turnpoint?
- How am I going on task?
- How far am I from home?
- How long have I been flying?
- I’m running out of lift; how do I get back to a thermal?
- Will I make it home?
- I'm not going to make it home; where can I land?
- I've outlanded; where am I?

Two problems XCSoar can't solve

- XCSoar can't teach you to use XCSoar
  - Like it or not, you need to read the manual if you want to use XCSoar successfully
  - And yes, you need to read it more than once
  - And no, you can't read it in the air…
- XCSoar can't make you fly safely
  - You're the Pilot In Command, so you're responsible for the decisions you make and the actions you take
  - XCSoar provides you with information, but you need to use that information wisely
  - Any glide computer can be a distraction if you let it; remember that your primary responsibility is to fly the aircraft ("aviate, navigate, communicate")
  - Computers can fail, so you still need a compass and charts for cross-country flying, and you must know how to use them

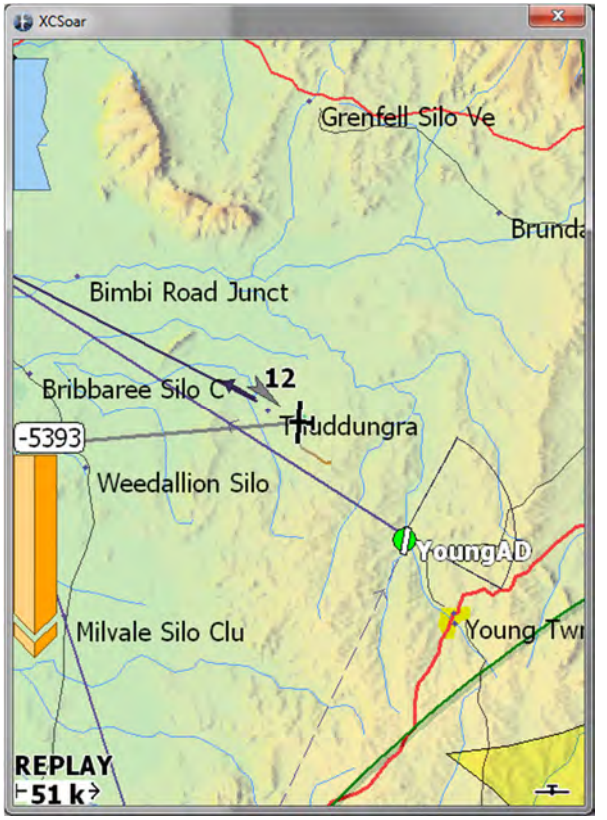
A few points before we proceed

- In the rest of the presentation, I assume you have already loaded maps into XCSoar for the region where you are flying
- Rather than describe points in exhaustive detail, I include references to the XCSoar 6.7 manual (dated June 2014) which you can read for more information
- The configuration settings I describe and the InfoBoxes I show are the ones I have found most useful; you need to decide what is best for you
- I'll make this presentation available if you would like to refer to it later



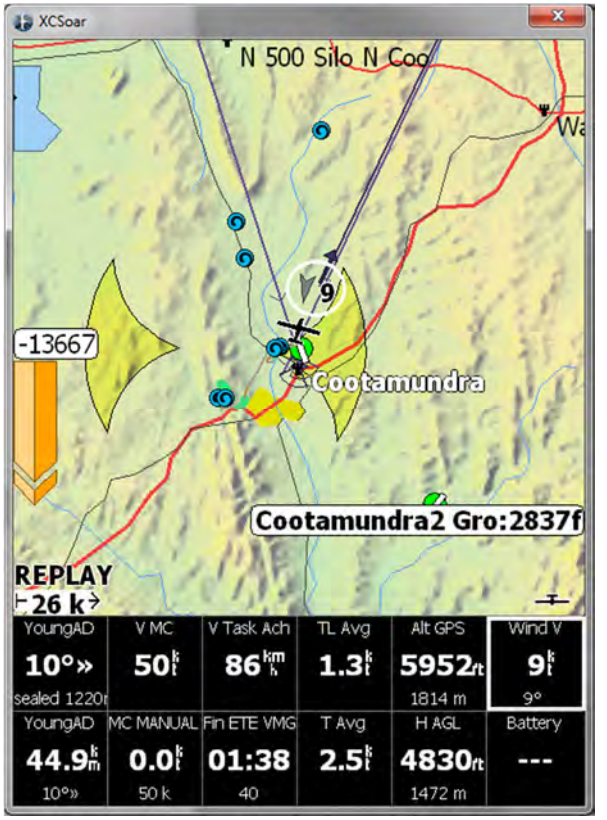
Where am I?

- XCSoar displays a moving map (see section 4.1 of the manual dated June 2014)
- You can zoom the map in and out (4.3)
  - Swipe up or down on the screen (3.12) or
  - Display/Zoom In and Display/Zoom Out (4.3)
- You can move the map around (4.4)
  - Display/Pan On, then move the map with your finger
- You can see more of the map by hiding the InfoBoxes temporarily (3.6, 3.12)
  - Swipe left or right on the screen
- You can orient the map in different ways: “north up” (north at the top), “track up” (the direction you are travelling), “heading up” (the direction you are pointed) or “target up” (the direction you want to go) (4.2, 6.12)
- I prefer “north up” so I can align the map with my charts and estimate compass bearings easily (4.2)
  - Config/Config/System/Map Display/Orientation/Cruise orientation=North up (13.5)
- If you want to align the map with the ground below, you can select “track up” or “heading up”, but the map tends to dance around, so “target up” is a better option (4.2)
  - Config/Config/System/Map Display/Orientation/Cruise orientation=Target up (13.5)



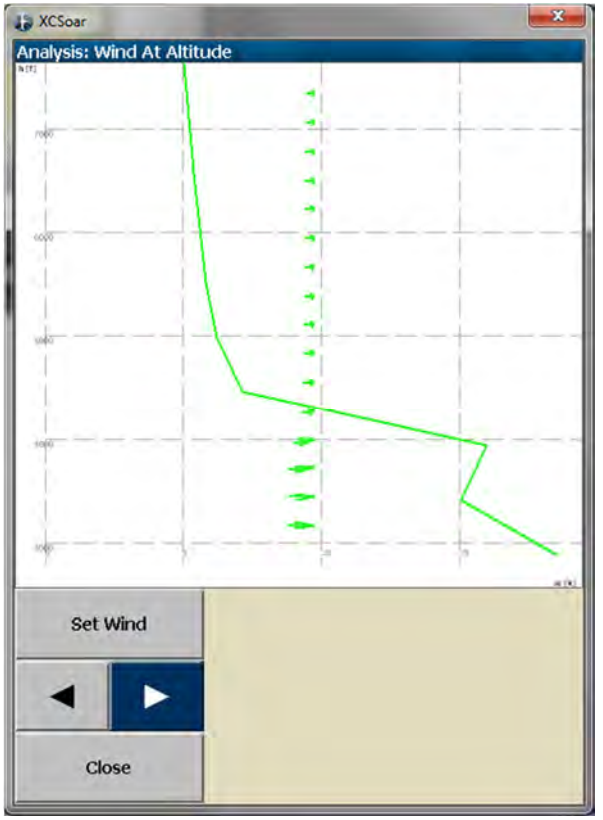
Which way is the wind blowing?

- XCSoar can automatically calculate the wind speed and direction from your drift whilst thermalling (7.5)
  - Config/Config/System/Glide Computer/Wind/Auto wind=Circling (13.12)
- XCSoar displays a grey arrow on the map showing the wind speed and direction (7.4)
- When a significant change in wind speed or direction is detected, XCSoar displays an alert (6.15)
- The “Wind speed” InfoBox shows the speed and direction of the wind (12.5)
- The “Wind arrow” InfoBox shows the wind direction graphically, but the arrow is oriented “heading up”, which may be confusing if you have the map oriented “north up” (12.5)



Which way is the wind blowing?

- The wind varies with altitude in both speed and direction; XCSoar collects this information during flight and can display it graphically (7.11)
  - Info/Analysis/Wind At Altitude
- Warning: wind speed and direction change over time; since you are likely to spend most of the flight up high, the wind information recorded for low altitude may no longer be current!
- Warning: when landing or outlanding, always confirm the wind direction at ground level using indicators other than XCSoar!



How do I centre this thermal?

- XCSoar can zoom in when circling, making it easier to see the “snail trail” and its indications of lift strength (4.3)
  - Config/Config/System/Map Display/Orientation/Circling zoom=On (13.5)
- XCSoar records your climb rate whilst thermalling and can display this in a “thermal assistant” at the bottom left of the screen, which you can use to centre the thermal (7.9)
  - Config/Config/System/Gauges/FLARM, Other/Thermal assistant=On (13.14)
- I’ve generally not found the thermal assistant very helpful; when thermalling, I’m focused on flying the aircraft and don’t have time to look at XCSoar
- I’ve not found the thermal assistant any better than the techniques we’ve all been taught for centring thermals
- The only time I’ve found it useful is if I’ve lost contact with the thermal, and the indicator points me to where I can reconnect
- The “Circle Diameter” InfoBox shows your circle size in metres and circle time in seconds, which you may find helpful (undocumented)
- Warning: don’t let XCSoar be a distraction when you should be looking outside the aircraft!

How good are the flying conditions?

- XCSoar has a number of InfoBoxes which indicate how good the flying conditions are
- “Last thermal average” and “Thermal average” show the average climb rate in the last thermal and in the current thermal, in knots (12.4)
- “Last thermal gain” and “Thermal gain” show the height gained in the last thermal and in the current thermal, in feet (12.4)
- “Last thermal time” shows the amount of time spent climbing in the last thermal (12.4)
- “Thermal average over all” shows the average climb rate for all thermals, in knots (12.4)

How good are the flying conditions?

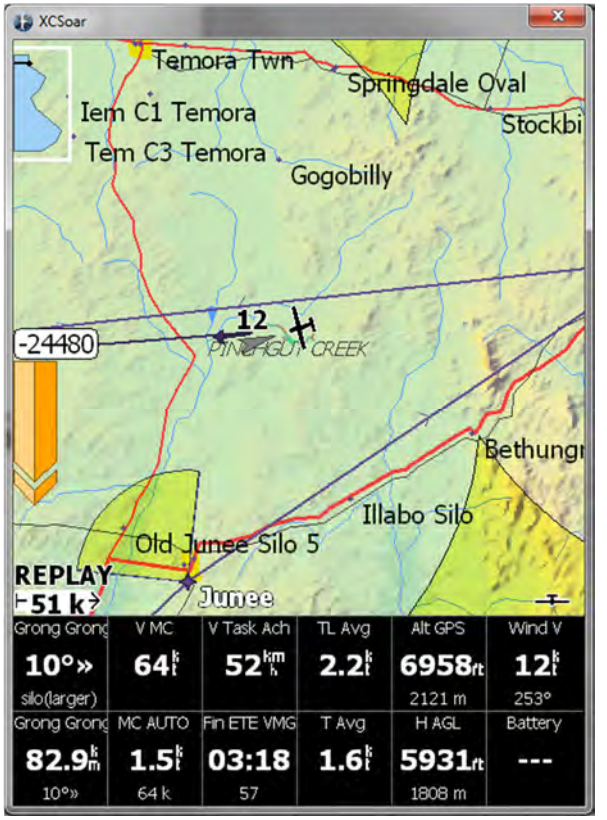
- XCSoar can display a bar chart showing the average climb rate for the last 20 thermals, in knots (5.15)
  - Info/Analysis/Climb
- The current MacCready setting is shown by the red line
- The trend is indicated by the blue line

How fast should I fly?

- XCSoar can calculate the optimal speed to fly based on the aircraft's performance characteristics and the expected lift strength, using MacCready Theory (6.6)
  - You need to configure the aircraft type and performance, as described later
- You can set the expected lift strength (the "MacCready setting") manually (6.2)
  - Config/MacCready+ or Config/MacCready-
- You can allow XCSoar to calculate the recommended MacCready setting automatically (6.13)
  - Config/Config/System/Glide Computer/Glide Computer/Auto MC mode=Both (13.11)
  - Config/MacCready Auto (6.13)
- XCSoar can cater for the fact that whilst you can afford to fly faster at high altitude, you need to be more conservative as you get closer to the ground (6.7)
  - Config/Config/System/Glide Computer/Safety Factors/STF risk factor=0.3 (13.10)
- The "Speed MacCready" InfoBox shows the optimal speed to fly at the current MacCready setting (12.6)
- The "MacCready Setting" InfoBox shows the current mode (manual or automatic) and current value (12.6)

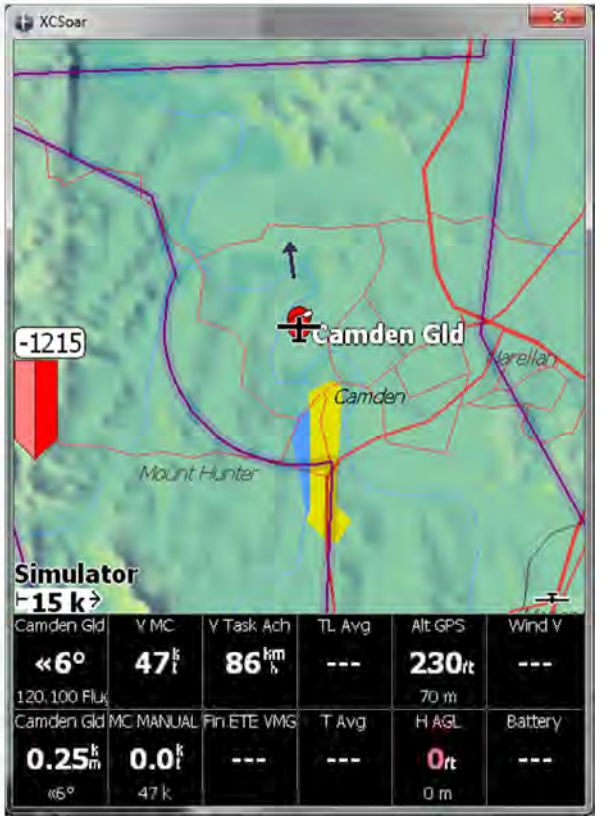
How high should I fly?

- A canny pilot once advised me to “Get high, stay high”, and whilst that provides a good chance of making it home, it can result in a long, slow flight
- XCSoar records your average climb rate at different heights and can display this in a “thermal profile” indicator at the top left of the screen, which you can use to judge the optimal height band to fly in (7.7)
  - Config/Config/System/Gauges/FLARM, Other/Thermal band=On (13.14)
- The Y axis indicates height, the X axis indicates climb rate and the black arrow indicates your current height within the band
- Warning: lift strength changes over time; since you are likely to spend most of the flight up high, the lift strength information recorded for low altitude may no longer be current!



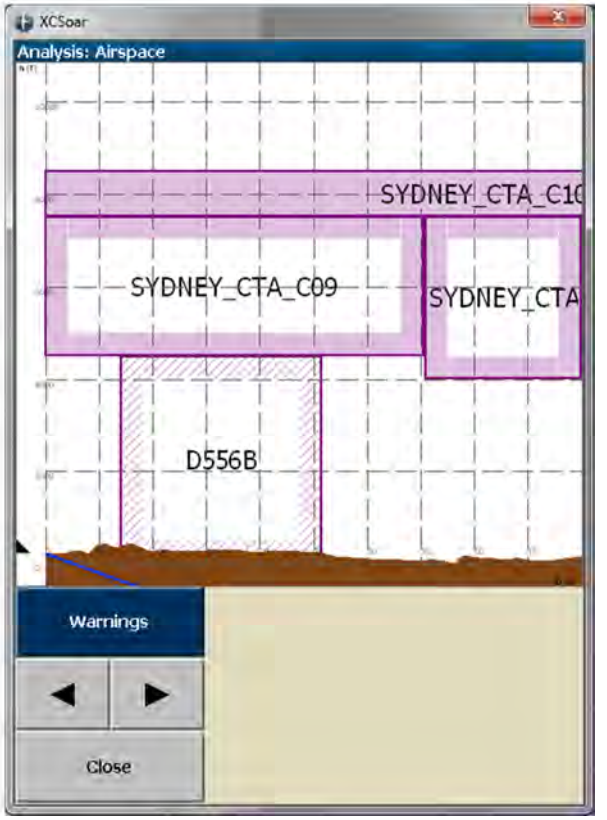
Am I infringing airspace restrictions?

- XCSoar can display airspace boundaries on the map (8.1)
  - Config/Config/System/Map Display/Airspace/Airspace display=Auto (13.9)
- If airspace information isn't embedded within your map database, you need to supply an airspace file and configure XCSoar to use it (14.4)
  - Config/Config/System/Site Files/Site Files/Airspaces (13.4)
- XCSoar can display colour-coded alerts as you approach an airspace boundary and if you infringe the airspace (8.2)
  - Config/Config/System/Map Display/Airspace/Warnings=On (13.9)
  - Config/Config/System/Map Display/Airspace/Margin=500 ft (13.9)



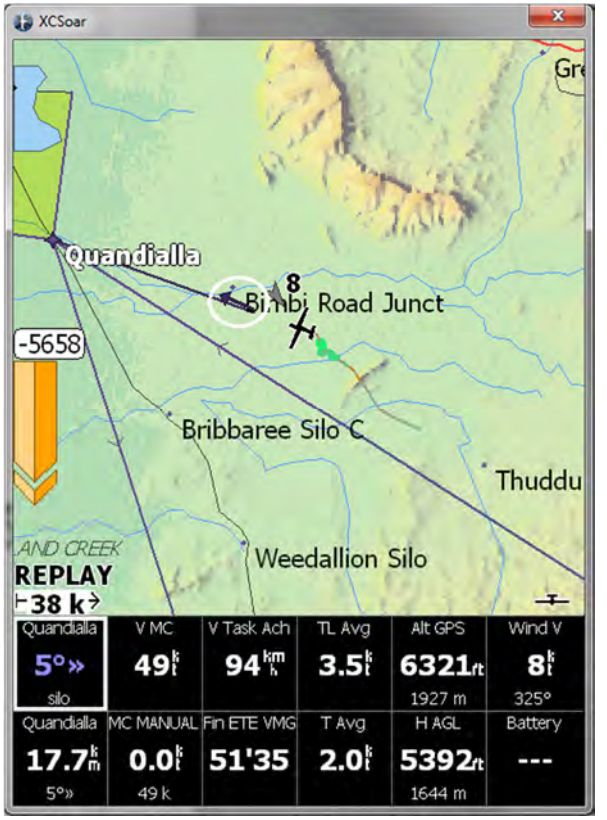
Am I infringing airspace restrictions?

- XCSoar can display a diagram showing the airspace from ground level upwards (8.4)
  - Info/Analysis/Airspace
- The diagram displays the airspace from where you are (left) to 50 km ahead in the direction you are tracking (right) (8.4)
- Your current height is indicated by the black arrow on the left (8.4)



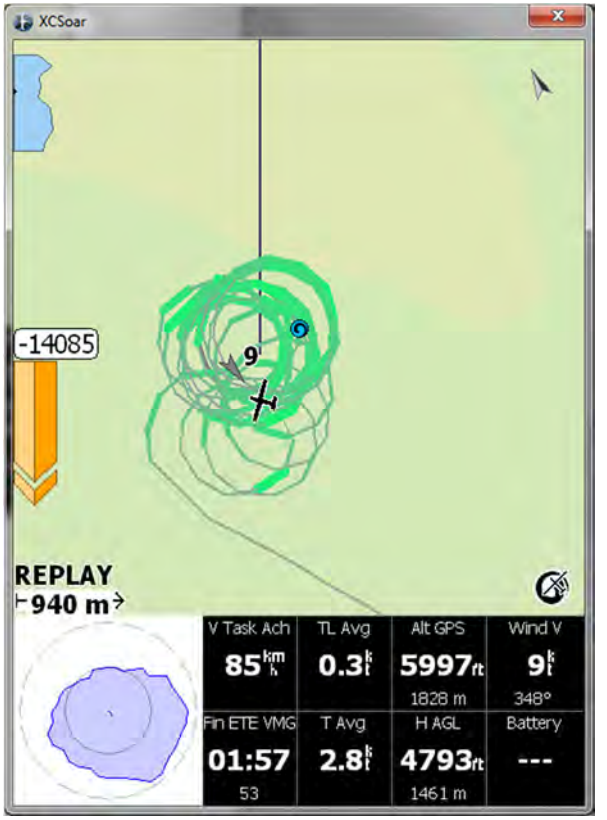
Which direction should I fly?

- XCSoar displays a dark blue arrow on the map indicating the direction to fly to the next turnpoint (6.12)
- If there is no wind, the optimal direction is towards the next turnpoint, but if there is a crosswind, you need to head slightly upwind; XCSoar takes this into account (6.12)
- The “Next waypoint” InfoBox shows the name of the next turnpoint and the direction to steer towards it, with chevrons pointing left or right (12.9)



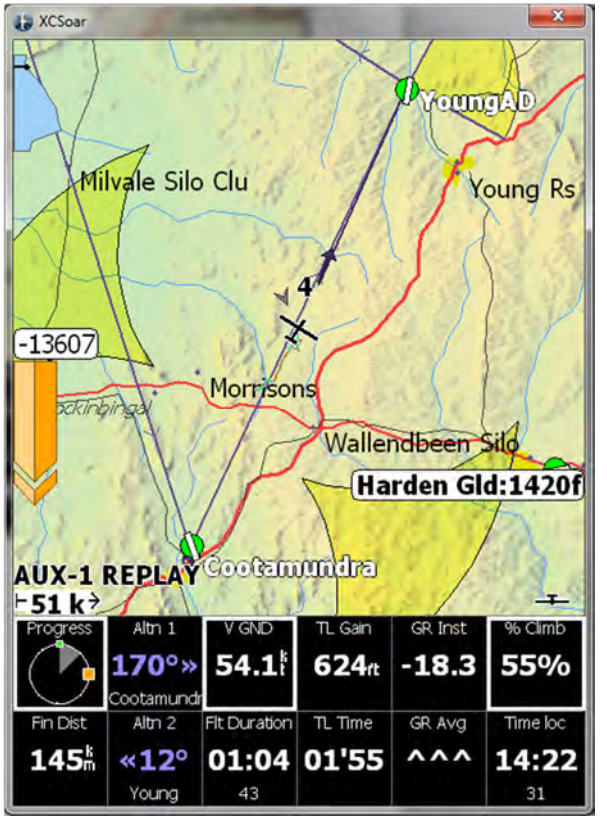
Which direction should I fly?

- XCSoar has separate map orientations for “cruise” and “circling” modes (4.2)
- When thermalling, I orient the map “target up” so I can easily see which direction to exit the thermal (4.2)
  - Config/Config/System/Map Display/Orientation/Circling orientation=Target up (13.5)



How well am I flying?

- XCSoar has a number of InfoBoxes which indicate how well you are flying
- “Speed ground” shows your ground speed, in km/h (12.2)
- “Percentage climb” shows the proportion of time spent thermalling (12.6)
- “Task cruise efficiency” shows your cruise efficiency compared with optimal MacCready performance, although what this actually means is not explained (12.6)
- “Speed task achieved” shows your task speed, in km/h (12.8)
- “Task progress” displays a clock-face indicator of progress through the task (12.8)
- “Speed task last hour” shows your average cross-country speed over the past hour, in km/h (undocumented)

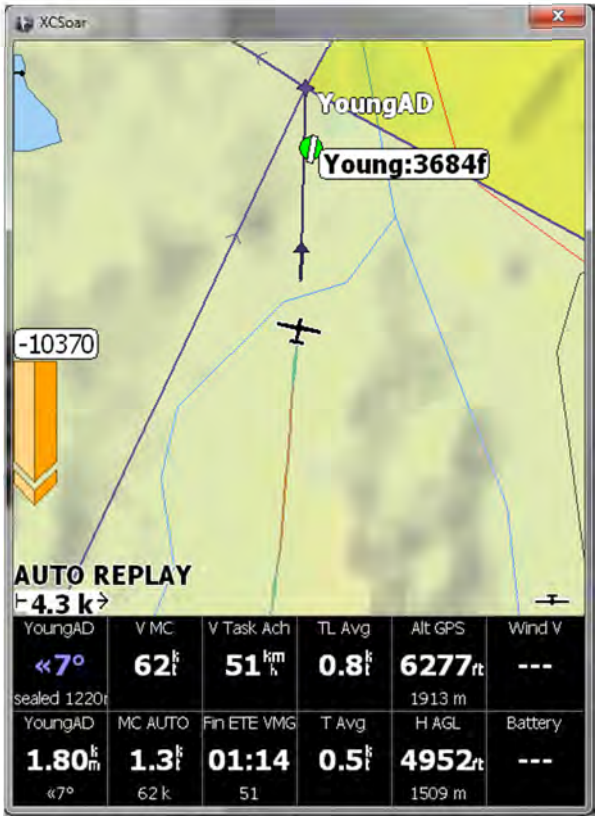


How far to the next turnpoint?

- XCSoar has a number of InfoBoxes which indicate the distance and time to the next turnpoint
- “Next distance” shows the distance to the next turnpoint, in km, as well as the name and direction (12.7)
- “Next time to go” shows the time remaining to reach the next turnpoint, assuming (probably unrealistically) that the ideal MacCready speed is achieved (12.9)
- “Next time to go (ground speed)” shows the time remaining to reach the next turnpoint, assuming the current ground speed (12.9)

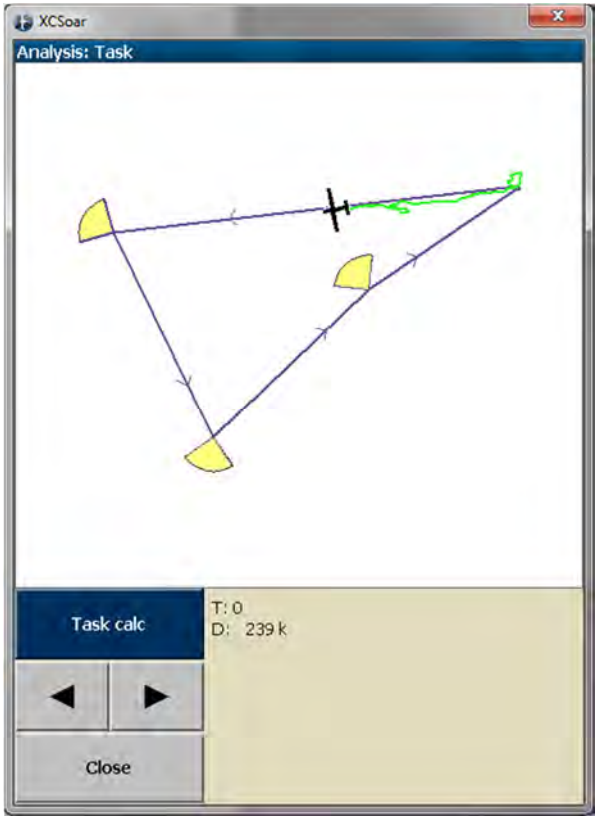
How do I ensure that I fly around the turnpoint?

- XCSoar can zoom in on the map when approaching a turnpoint so you don't miss it (4.3)
  - Display/Zoom Auto
- You don't want to have your badge claim rejected by the Badge Lady!
  - www.youtube.com/watch?v=TZvqSXmPB6Y



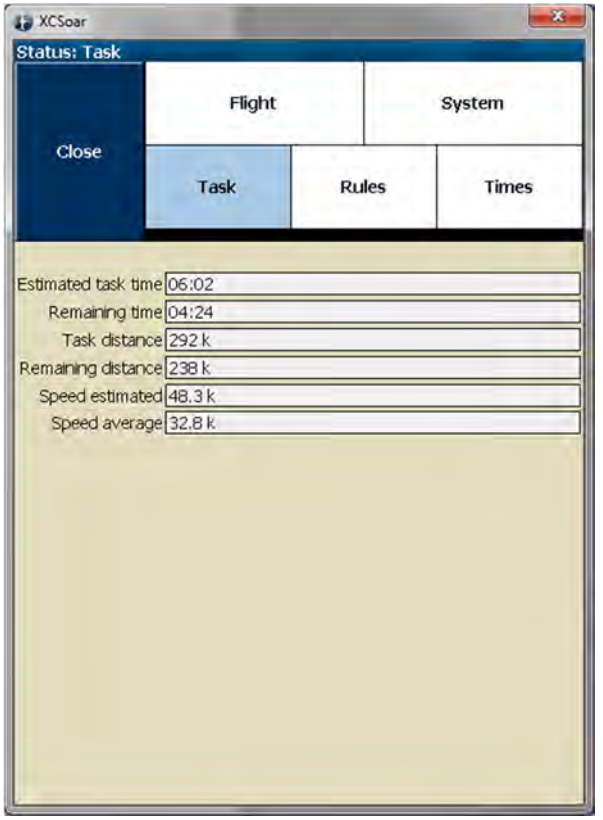
How am I going on task?

- XCSoar can display a diagram showing your progress on task (5.15)
  - Info/Analysis/Task



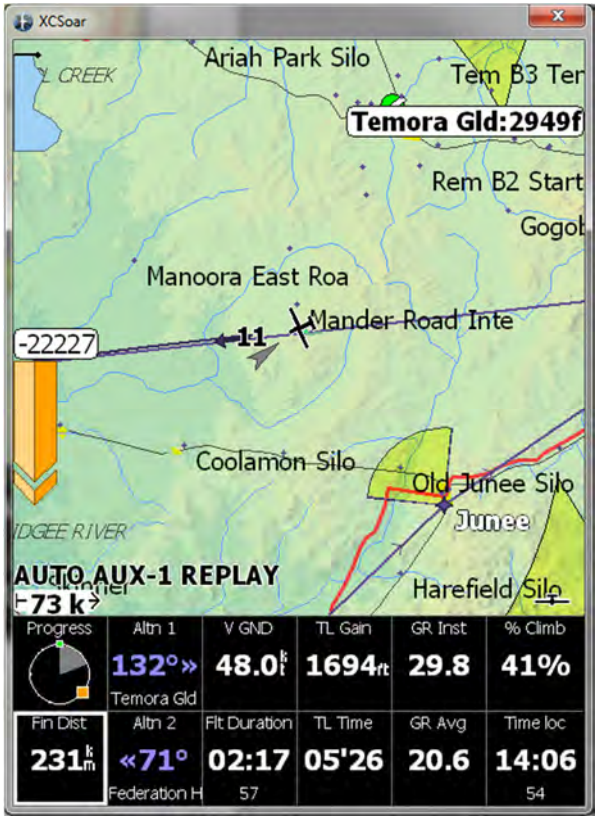
How am I going on task?

- XSCoar can display a summary of time, distance and speed information for the task (4.12)
  - Info/Info/Status/Task



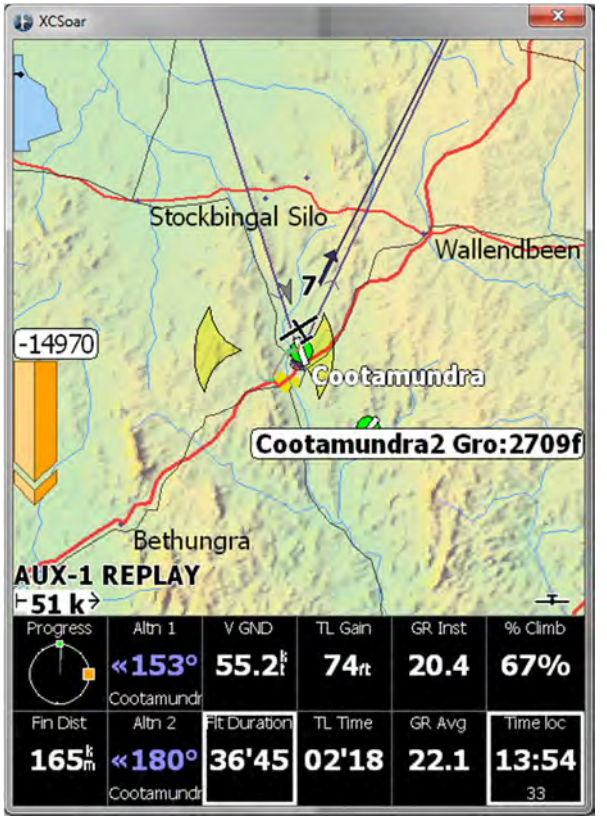
How far am I from home?

- XCSoar has a number of InfoBoxes which display distance from home information
- “Final distance” shows the distance around the remaining turnpoints, in km (12.7)
- “Distance home” shows the distance to the home waypoint, if one is defined, in km (12.7)
- “Distance takeoff” shows the distance and direction to the take-off point (undocumented)



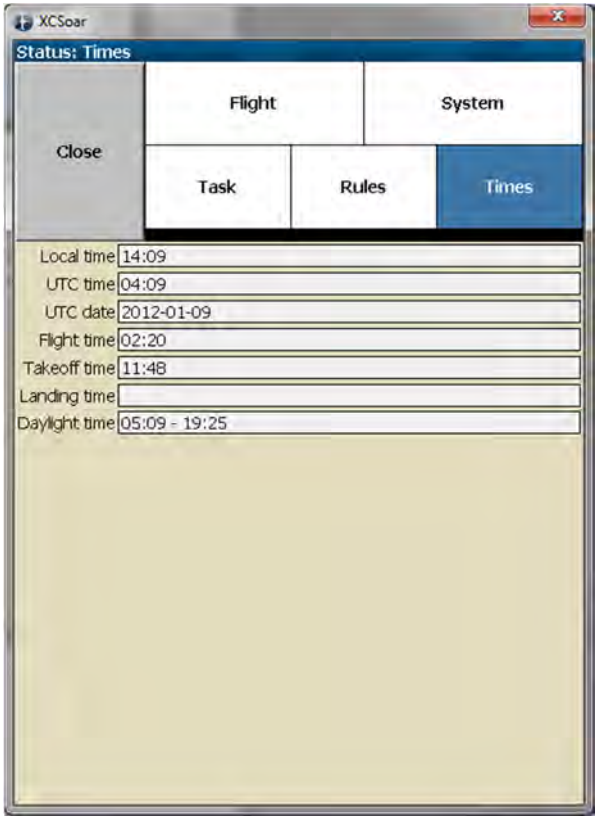
How long have I been flying?

- XCSoar has a number of InfoBoxes which display time information
- “Time local” shows the current time of day (12.9)
- “Flight duration” shows the elapsed time since take-off (12.9)
- “Task time to go (ground speed)” shows the estimated time remaining to complete the task at the current ground speed (12.9)
- “Task arrival time” shows the estimated time of day you will complete the task, assuming the ideal MacCready speed is achieved (12.9)
- Unfortunately there isn’t any “Task arrival time (ground speed)” InfoBox
- XCSoar displays the time of day in “hh:mm $_{ss}$” format, and elapsed time in “mm’ss” format if less than an hour, or “hh:mm $_{ss}$” otherwise (undocumented)



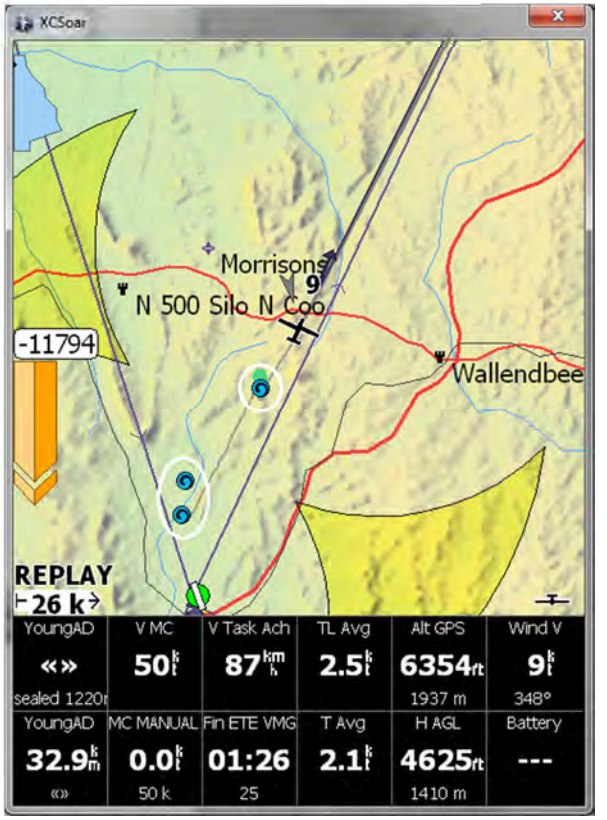
How long have I been flying?

- XCSoar can display a summary of time information on the one screen (undocumented)
  - Info/Info/Status/Times
- XCSoar understands how the date and location affect the time of local sunset, and will display a warning if the estimated task completion time is after sunset (5.16)



I'm running out of lift; how do I get back to a thermal?

- XCSoar displays markers for the last 20 thermals you circled in (4.10, 7.8)
  - Note: section 4.10 of the manual says markers for all thermals are displayed, which is incorrect
- The location of the marker on the map is adjusted to account for wind drift with height (7.8)
- If you tap on a thermal marker, XCSoar displays information about the average lift strength and how long ago you were there (4.10, 5.3)
- Warning: none of the above guarantees the thermal will still be there!



I'm running out of lift; how do I get back to a thermal?

- XCSoar can display a "snail trail" which is colour-coded to indicate rising air (4.8)
  - Config/Config/System/Map Display/Elements/Trail length=Short (13.6)
  - Config/Config/System/Map Display/Elements/Trail type=Vario #1 (13.6)
- The width of the trail can indicate the strength of the lift (4.8)
  - Config/Config/System/Map Display/Elements/Trail scaled=On (13.6)
- The location of the trail can be adjusted for wind drift (4.8)
  - Config/Config/System/Map Display/Elements/Trail drift=On (13.6)

Will I make it home?

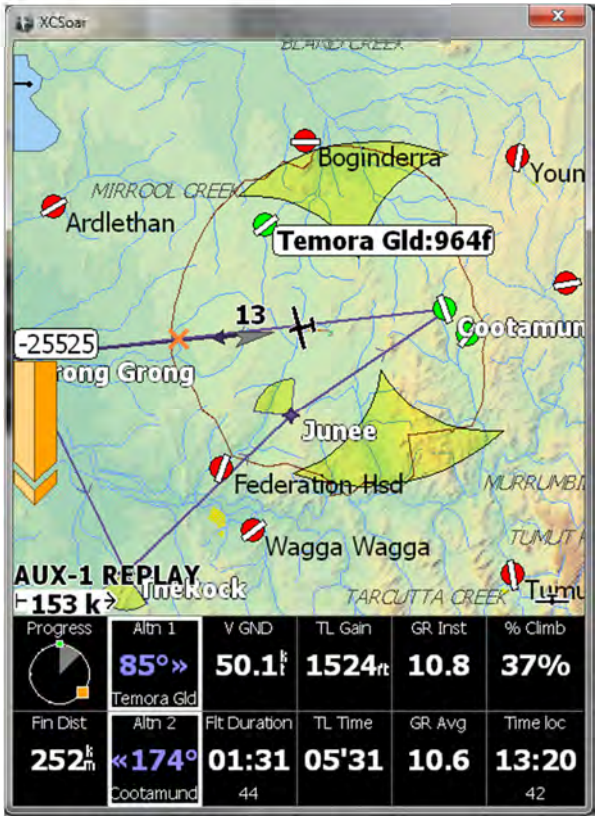
- XCSoar can display a colour-coded above/below final glide indicator on the left of the screen, with the height margin or the amount of height still required (6.10)
  - Config/Config/System/Gauges/FLARM, Other/Final glide bar=On (undocumented)
- Green indicates above final glide, so if you have a comfortable margin you should make it home; red indicates below final glide, so you have more thermalling to do
- If you are below final glide but there are landable waypoints within glide range, the bar is orange
- The bar is usually split vertically; the left half indicates above/below final glide at the current MacCready setting, and the right half using a MacCready setting of zero ie assuming no more lift (6.10)
  - Config/Config/System/Gauges/FLARM, Other/Final glide bar MC0=On (13.14)
- This works at Camden as well!; if you haven't declared a task, XCSoar treats the take-off point as your intended destination (5)
- If you are below final glide you will drift with the wind whilst thermalling; XCSoar can take this into account (6.10)
  - Config/Config/System/Glide Computer/Glide Computer/Predict wind drift=On (13.11)

Prerequisites for glide range calculations

- So that XCSoar knows the performance of your aircraft, you need to configure the type of aircraft you are flying before each flight (6.3)
  - Config/Config/Plane (13.28)
- You need to configure the minimum safety height you want to arrive at a landing place so you can do a proper circuit (6.8)
  - Config/Config/System/Glide Computer/Safety Factors/Arrival height=1000ft (13.10)
- No aircraft performs as well as when fresh from the factory, so you need to configure a "fudge factor" to reflect the slightly reduced performance (6.3)
  - Config/Config/System/Glide Computer/Safety Factors/Polar degradation=5% (13.10)
  - Note: this should really be set on a "per glider" basis rather than globally, but I haven't managed to convince the developers to provide this feature; however, XCSoar is open source, so I can add the feature myself if I really want it!
- Glider performance degrades during flight due to insects sticking to the wings, so you can configure XCSoar to reduce the expected performance by 1% per hour of flight time (undocumented)
  - Config/Config/System/Glide Computer/Safety Factors/Auto bugs=On
- You need to configure whether XCSoar should do glide range calculations using the current MacCready setting or a "safety" setting (it's safest to assume no more lift) (4.11)
  - Config/Config/System/Glide Computer/Route/Reach polar=Safety MC (13.13)
  - Config/Config/System/Glide Computer/Safety Factors/Safety MC=0.0 kt (13.10)

I'm not going to make it home; where can I land?

- XCSoar can display landable waypoints on the map, colour-coded to indicate whether they are within glide range (4.5)
  - Config/Config/System/Map Display/Waypoints/Landable symbols=Traffic lights (13.7)
- XCSoar can display next to landable waypoints within glide range the height margin you have above your safety height (4.5)
  - Config/Config/System/Map Display/Waypoints/Arrival height=Terrain avoidance glide (13.7)
- XCSoar can display a shaded region on the map showing the area within glide range above your safety height (4.11)
  - Config/Config/Glide Computer/Route/Reach display=Shade (13.13)
- XCSoar has InfoBoxes showing the name of and direction to the two best alternate landable waypoints (12.12)
  - The direction is colour-coded blue if the alternate is within glide range (undocumented)



I'm not going to make it home; where can I land?

- XCSoar can display a list of six landable waypoints using colour-coding to indicate whether they are within glide range above your safety height (5.10)
  - Nav/Alternates
- You can sort the list by height margin, closest on track or closest heading home (5.10)
  - Config/Config/System/Glide Computer/Safety Factors/Alternates mode (13.10)

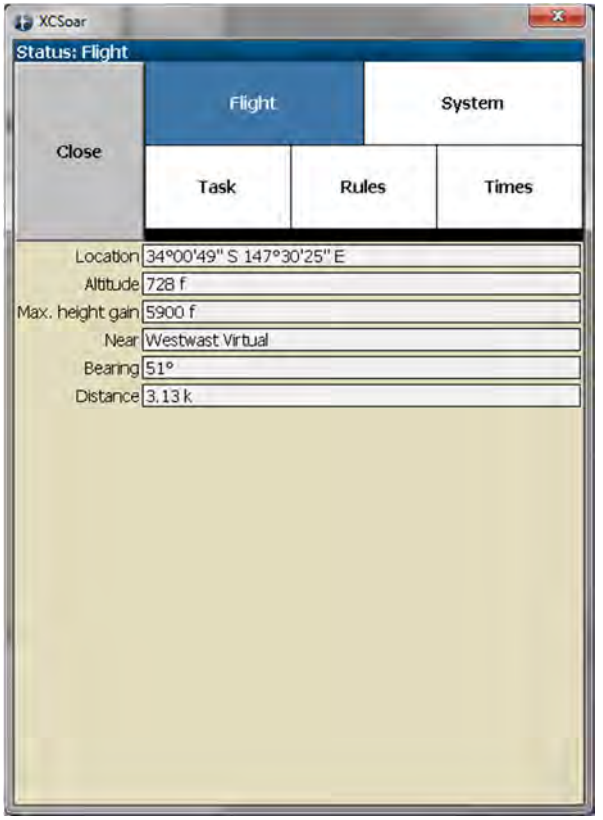
XCSoar
Alternates
Temora Gld
Distance: 28.9 k - Arrival Alt: +636 f - 126.150 MHz
Cootamundra Gld
Distance: 42.1 k - Arrival Alt: +280 f - 126.700 MHz
Federation Hsd
Distance: 42.0 k - Arrival Alt: -943 f - 126.700 MHz
Cootamundra2 Gro
Distance: 47.7 k - Arrival Alt: -128 f - 126.700 MHz
Boginderra
Distance: 50.8 k - Arrival Alt: -930 f - 126.700 MHz
Wagga Wagga
Distance: 55.4 k - Arrival Alt: -1569 f - 118.200 MHz
Goto
Details
Close

Warnings regarding glide range calculations

- Just because XCSoar thinks an airfield is landable doesn't mean it is (perhaps the airfield is closed)
- Just because XCSoar thinks an airfield is within glide range doesn't mean it is (perhaps there's a wind change coming)
- You should err on the side of caution; the large flat paddock below may be a safer option than the airfield on the edge of your reported glide range

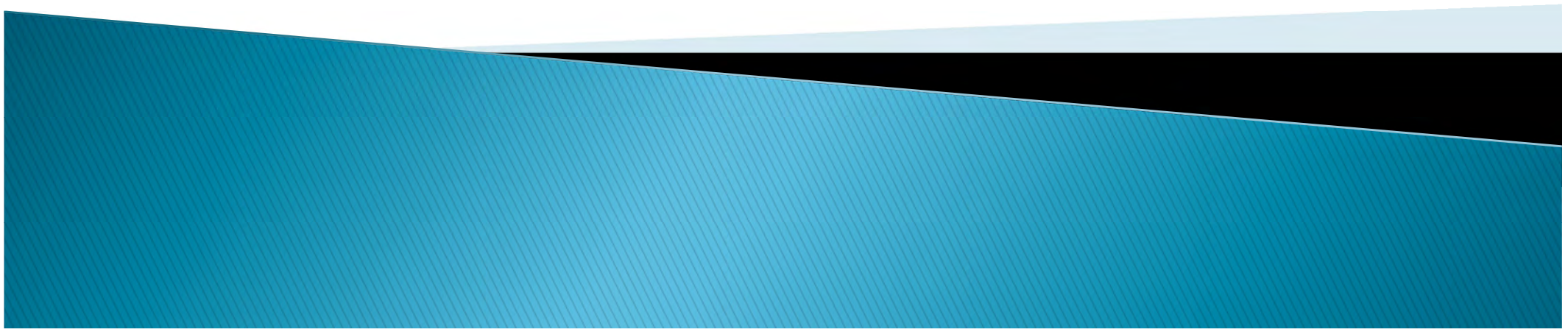
I've outlanded; where am I?

- XCSoar can display the current GPS coordinates, and the direction and distance to the nearest waypoint (4.12)
  - Info/Info/Status/Flight



Any questions?

I've lots of answers, some of them right...



Thank you for your attention

You've been a wonderful audience